BRIEF NOTE

Comparative Morphology of the First-Stage Larvae of Two Species of *Philometra* (Nematoda: Philometridae) and One Species of *Camallanus* (Nematoda: Camallanidae) From Lake Erie Fishes[1]

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ABSTRACT. **Previous descriptions of larval philometrids and camallanids are based on observation from light microscopy. First-stage larvae of *Camallanus oxycephalus, Philometra cylindracea,* and *Philometra* sp. were examined by electron microscopy to determine whether differences seen in adult structure also occur in the larvae, allowing for identification of larval stages in the intermediate and definitive hosts. Similarities in larval structure supported some speculation as to the possible evolutionary link between these genera and their corresponding families.**

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INTRODUCTION

Philometra sp., *Philometra cylindracea* (Nematoda: Philometridae), and *Camallanus oxycephalus* (Nematoda: Camallanidae) are common parasites of various Lake Erie fishes. Although the philometrids appear to be fairly host-specific in Lake Erie, *Camallanus oxycephalus* is found in a wide variety of hosts. *Philometra* sp. was described by Crites (1975), and found to be specific to *Aplodinotus grunniens. Philometra cylindracea* was first described by Ward and Magath (1916) and redescribed by Stromberg et al. (1973). These descriptions were all based on adult specimens possessing many distinctive characteristics, allowing easy identification.

The primary intent of this investigation was to observe larval characteristics as a possible means of identifying larval nematodes found in intermediate and definitive hosts. First-stage larvae were used since this stage is easiest to collect.

MATERIALS AND METHODS

Fish were collected by various means in Lake Erie's western basin off South Bass Island. Larvagenous females were placed in lake water where they ruptured releasing first-stage larvae. Larvae were collected by centrifugation and fixed in 6% gluteraldehyde in cacodylate buffer. The larvae were processed for scanning electron microscopy (SEM), using critical point drying following alcohol dehydration, and were then placed on double-stick tape and coated with gold. The larvae were visualized using a Hitachi S-5000 scanning electron microscope. Although SEM was used to describe the larvae, light microscopy of living larvae was also performed to insure that structures seen were not artifacts of fixation.

RESULTS

Under light microscopy, first-stage larvae of all three species show a concave, oval-spatulate caudal end that from the side resembles a hook (Fig. 1a, 1b). Anterior to this structure is a small cuff. A large papilla-like structure is present on the cephalic end of all the larvae. No other structures are discernable at these magnifications.

SEM also shows the first-stage larvae of all three species to be very similar. There is a single, papilla-like structure located dorsally on the cephalic end. There appear to be labial ridges dorsal and ventral to the mouth and pseudolabia are present laterally (Fig. 2a, 2b, 2c). The clam-like buccal capsule (Fig. 3a) found in adult *Camallanus oxycephalus* is not present in the first-stage larvae of that species, nor do the cephalic structures of the larval philometrids resemble those of the adults (Fig. 3b). Instead, a pair of bar-like structures (oral bars), arranged laterally, lie within the oral opening. Lateral amphidial pores are present on the pseudolabia. The cuticle is striated and without ornamentation. In *Philometra* sp., an opening is present on the ventral surface about 75-100 μm from the posterior end (Fig. 4). This corresponds to the area where the degenerate rectum attaches in adults of the same species (Fig. 5). The caudal area is oval-spatulate and appears somewhat flexible. The tail narrows to a small cuff (Fig. 6a, 6b, 6c). Phasmidial pores do not appear to be present at this stage, and no other structures are seen.

DISCUSSION

Both the philometrids and camallanids belong to the order Spirurida. The life cycles of the three species used in the present study are very similar, and this may explain similarities in structure. The first-stage larvae are released into the water, where they are ingested by the copepod intermediate host. The larvae penetrate to the haemocoel of the copepod and moult several times. When copepods containing third-stage larvae are ingested by the definitive host, larvae are released into the digestive tract of the fish, migrate to target organs, and moult to adults. Major morphological changes occur during this time, and it would seem likely that many of these changes occur because of the change in host.

The single papilla-like structure seen anteriorly on all three species has been described in these and other species as an egg tooth. Sections through this structure show an association with a sensory cilium and a lack of any secretory structures (Kelly 1983). This is in concurrence with Hendrick's (1935) description of the cuticular tooth of *Spiroxys contortus* (Nematoda: Spiruridae). He hypothesized that the cuticular tooth was a mechanical aid to penetration of the copepod gut wall by the first-stage larva, and that this tooth was lost

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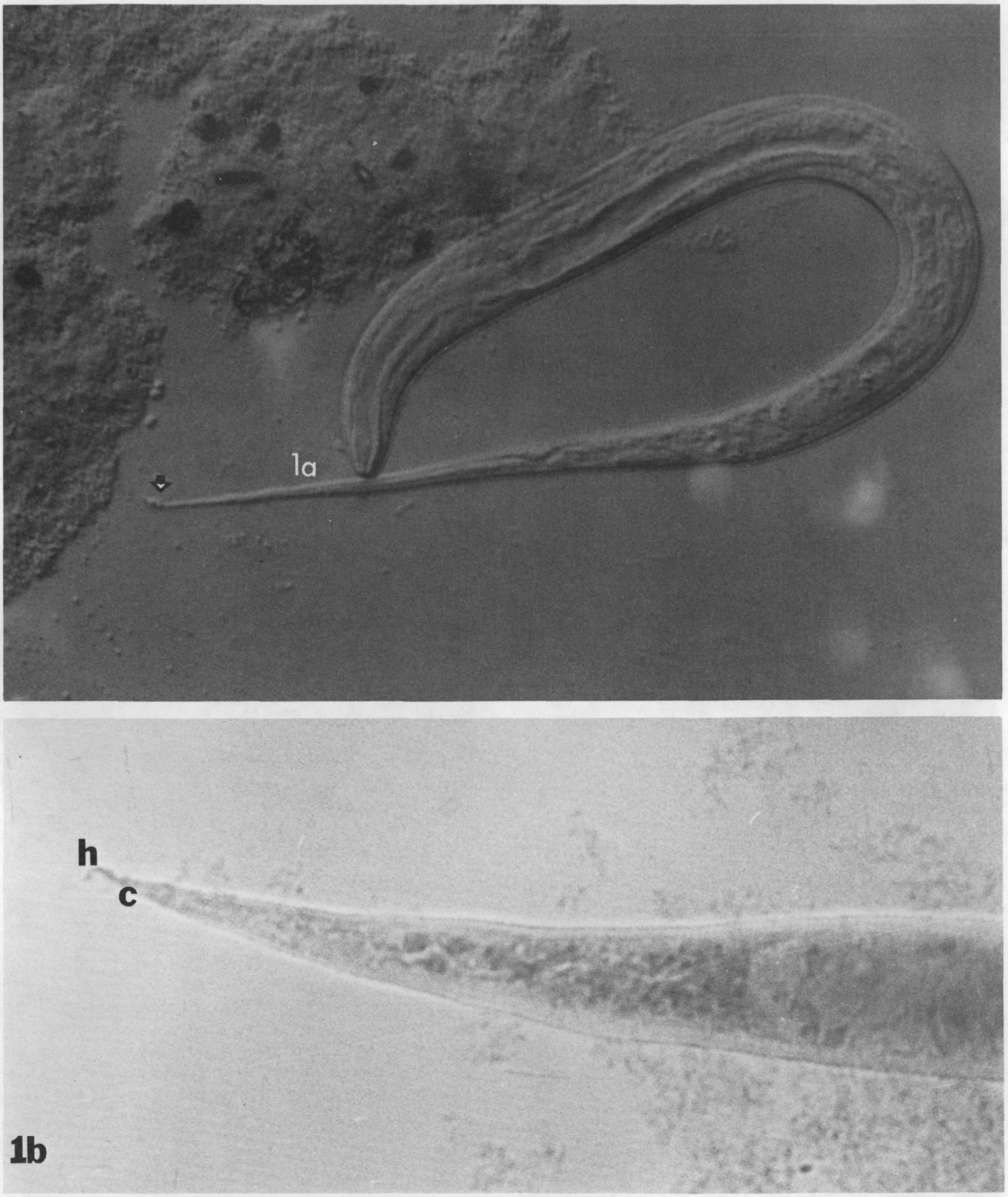

FIGURE 1. Light micrograph of *Philometra* sp. showing: a) the entire first-stage larva (1000×) and b) posterior end (5000×) showing the cuff (c) and oval-spatulate area of the tail (h).

when the larva moults (Hendrick 1935). An egg tooth is seen on many larvae that have copepod intermediate hosts. Chitwood and Chitwood (1950) described the first-stage larvae of Dracunculoidea as having a cephalic dorsal denticle. The first-stage larvae of *Procamallanus* also have a dorsal spine, possibly for penetrating the copepod intestinal wall (Li 1935).

Although Chitwood and Wehr (1934) described philometrids as being distinctive among the spirurids because of their lack of any cuticular projections, Crites

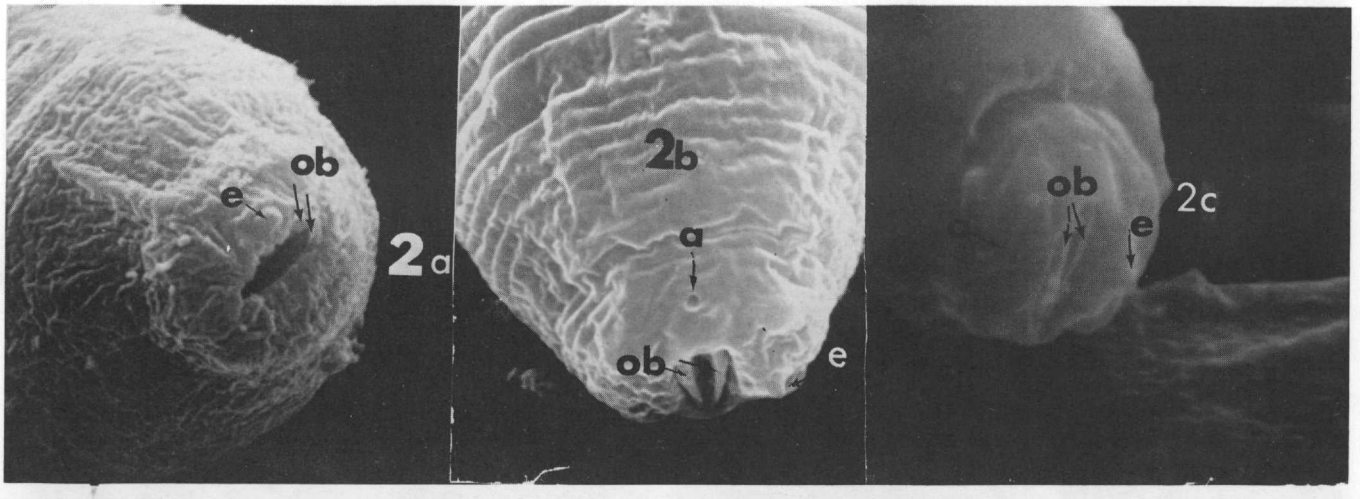

FIGURE 2. Scanning electron micrograph of the anterior end of: a) *Camallanus oxycephalus* (10,000×), b) *Philometra* sp. (10,000×), and c) *Philometra cylindracea* (10,000×) showing oral bars (ob), amphids (a), and the egg tooth (e).

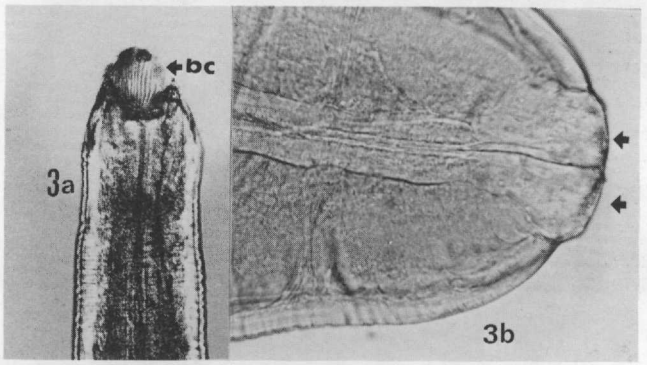

FIGURE 3. Light micrograph of: a) adult *Camallanus oxycephalus* (5×) and b) adult *Philometra* sp. (13×) showing the anterior end (arrow) and the buccal capsule (bc).

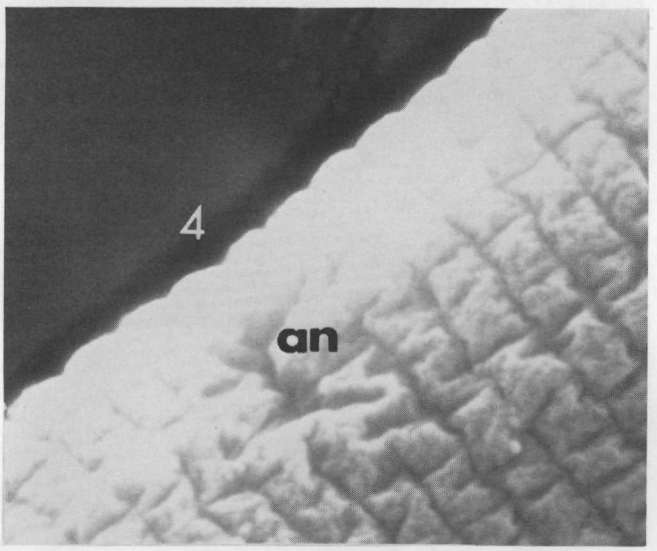

FIGURE 4. SEM of the ventral surface of the first-stage larva of *Philometra* sp. (20,000×) showing the anal opening (an).

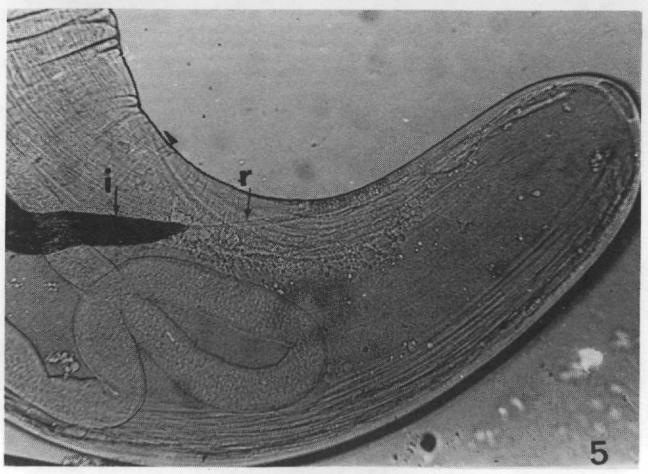

FIGURE 5. Light micrograph of adult *Philometra* sp. (10×) showing the attachment site of the degenerate rectum (r) and the intestine (i).

(pers. commun.) described adult female *Philometra* sp. as having three lip-like structures and circumoral papillae that degenerate with maturity. The description of *Philometra cylindracea* adults (Ashmead and Crites 1975) is very similar. Adult camallanids have a distinctive clam-like buccal capsule, while adult philometrids were described by Yamaguti (1961) as having no buccal capsule. First-stage larvae are reported to be similar to adults in body form with no real changes occurring during development (Schmidt and Roberts 1977). However, there are many differences between adult and larvae of both *Philometra* and *Camallanus*. The first-stage larvae observed did have lateral amphidial pores, but lacked any other adult structures. The bar-like structures present within the oral opening have no known counterpart in the adult. The purpose of these oral bars is unknown. Electron micrographs of these bars show them to contain hypodermis and muscle, and to be lined with cuticle continuous with the external cuticle (Kelly 1983).

The opening seen on the ventral surface of *Philometra* sp. is thought to be the anal opening. However, it is not connected to the undifferentiated digestive tract (Kelly 1983). Stromberg and Crites (1974) described an

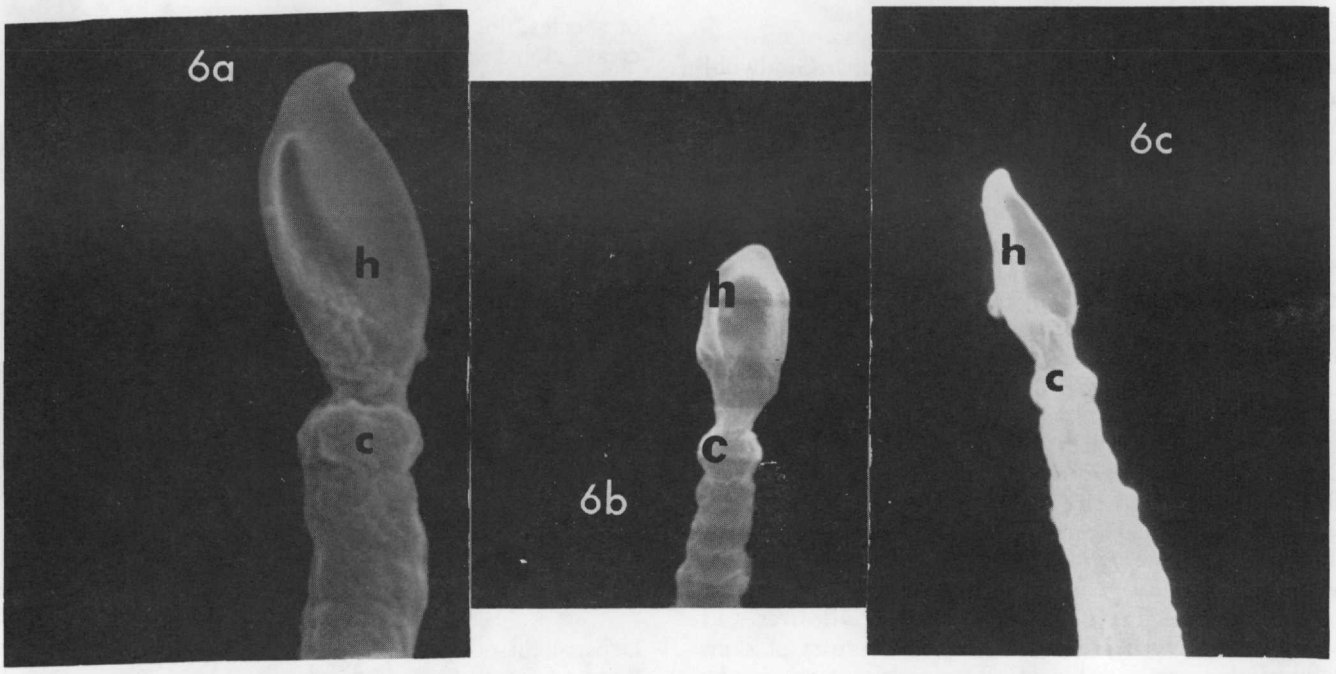

FIGURE 6. SEM of the posterior end of the first-stage larva of: a) *Camallanus oxycephalus* (20,000×), b) *Philometra cylindracea* (10,000×), and c) *Philometra* sp. (10,000×) showing the cuff (c) and oval-spatulate area of the tail (h).

anal opening for *Camallanus oxycephalus* larvae viewed under light microscopy. It is likely this structure is also present in *Philometra cylindracea.* This anal opening is lost in adult philometrids and retained in adult camallanids. The phasmids, present on all adult spirurids, were not seen on any of the larvae observed in the present study.

Nematodes of the family Philometridae produce free-swimming first-stage larvae that attach, by their tails, to particles in the water. This attachment behavior is also seen in the Camallanidae, and appears to enhance the ability of the larvae to attract copepods, the intermediate host (Stromberg and Crites 1974). The oval-spatulate caudal area was found to contain rows of muscle (Kelly 1983). Thomas (1929) proposed the presence of cement glands within the tail of first-stage larvae of *Philometra (Philometroides) nodulosa,* a related species, but no secretory structures were seen in this area on the three species observed in this study. It is quite possible that the oval-spatulate structure described is utilized as a muscular grasping organ or sucker, enabling the larvae to attach to the substrate.

It would seem then that the identification of any of these three species by morphological characteristics of the first-stage larvae is not possible. The homology of these two families within the order Spirurida may be shown by the similarities in larval cephalic structures. The many similarities between these first-stage larvae may indicate an evolutionary link between these genera. However, it is just as likely that the similarities in morphology result from evolutionary convergence related to the similarities in behavior exhibited by the larvae because they utilize the same intermediate host.

ACKNOWLEDGMENTS. We would like to thank F. T. Stone Laboratory for use of their facilities.

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